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On-load-tap-changers

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CONTENTS

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ON-LOAD TAP-CHANGERS

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

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4) The IEC has not laid down any procedure concerning marking as an indication of approval and has no responsibility when an item of equipment is declared to comply with one of its recommendations.

PREFACE

This standard has been prepared by Sub-Committee 14B: On-load tap-changers, of IEC Technical Committee No. 14: Power transformers.

This third edition of IEC Publication 214 replaces the second edition issued in 1976.

The text of this standard is based upon the following documents:

Six Months' Rule	Report on Voting
14B(CO)14	14B(CO)17

Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

The following IEC publications are quoted in this standard:

Publications Nos. 60: High-voltage test techniques.

76-1 (1976): Power transformers, Part 1: General.

76-3 (1980): Part 3: Insulation levels and dielectric tests.

137 (1984): Bushings for alternating voltages above 1 000 V.

144 (1963): Degrees of protection of enclosures for low-voltage switchgear and controlgear.

270 (1981): Partial discharge measurements.

296 (1982): Specification for unused mineral insulating oils for transformers and switchgear.

354 (1972): Loading guide for oil-immersed transformers.

542 (1976): Application guide for on-load tap-changers.

ON-LOAD TAP-CHANGERS

SECTION ONE - GENERAL

1. Scope

This standard applies to on-load tap-changers* for power transformers and their motor-drive mechanisms. It relates mainly to tap-changers immersed in transformer oil according to IEC Publication 296, but may also be used for gas-insulated tap-changers in so far as conditions are applicable.

Note.- For the purpose of this standard, a synthetic insulating liquid is regarded as an oil. A synthetic insulating liquid can be used for a tap-changer only if it is compatible with the tap-changer design.

Tap-changers for transformers for railway rolling stock are excluded from this standard.

In selecting a tap-changer for a particular application, reference should be made to IEC Publication 542.

2. Service conditions

a) Temperature of tap-changer environment

Unless more onerous conditions are specified by the purchaser, tap-changers are regarded as suitable for operation over the ranges of temperature given in Table 1.

Table 1 - Temperature of tap-changer environment

Tap-changer environment	Temperature	
	Minimum	Maximum
Air	-25 °C	40 °C
Oil	-25 °C	100 °C

* See Note to Sub-clause 4.1.

Notes 1.- The tap-changer environment is the medium immediately surrounding the complete tap-changer, i.e., if the latter is enclosed in a separate external container, intended for mounting outside the transformer tank, the tap-changer environment is "Air"; if the complete tap-changer is intended for mounting inside the main transformer tank and not in a separate external container, then the tap-changer environment is "Oil" (i.e. the oil in the transformer tank).

2.- The value of 100 °C quoted above is based on a maximum ambient temperature of 40 °C as specified in IEC Publication 76.

b) Temperature of motor-drive mechanism environment

Unless more onerous conditions are specified by the purchaser, motor-drive mechanisms are regarded as being suitable for operation in any ambient temperature between -25 °C and 40 °C.

Note.- For more onerous conditions for tap-changer or motor-drive mechanism environments, reference should be made to IEC Publication 542, Sub-clause 5.3, Items 5 and 6.

c) Overload conditions

Tap-changers which comply with this standard and are selected and installed in accordance with Sub-clause 2.3.2 of IEC Publication 542 are compatible with loading of the transformer according to IEC Publication 354, where the oil temperatures are detailed.

3. Information required with enquiries and orders

For the information required with enquiries and orders, see IEC Publication 542.

SECTION TWO - DEFINITIONS

4. Definitions relating to on-load tap-changers (excluding motor-drive mechanisms)

For the purpose of this standard, the following definitions apply:

4.1 *On-load tap-changer*

A device for changing the tapping connections of a winding, suitable for operation whilst the transformer is energized or on load. Generally, it consists of a diverter switch (see Sub-clause 4.3) with a transition impedance (see Sub-clause 4.6) and a tap selector (see

Sub-clause 4.2) which can be with or without a change-over selector (see Sub-clause 4.5), the whole being operated by the driving mechanism (see Sub-clause 4.7). In some forms of tap-changers, the functions of the diverter switch and the tap selector are combined in a selector switch (see Sub-clause 4.4).

Note.- As the whole of this standard deals only with on-load tap-changers, the expression is shortened to "tap-changer" in the remainder of this publication.

4.2 *Tap selector*

A device designed to carry, but not to make or break, current, used in conjunction with a diverter switch, to select tapping connections.

4.3 *Diverter switch*

A switching device used in conjunction with a tap selector to carry, make and break currents in circuits which have already been selected.

Note.- Diverter switches of spring-operated type include an independent means of storing energy for their operation.

4.4 *Selector switch*

A switching device capable of making, carrying and breaking current, combining the duties of a tap selector and a diverter switch.

4.5 *Change-over selector*

A device designed to carry, but not to make or break, current, used in conjunction with a tap selector or selector switch to enable its contacts, and the connected tappings, to be used more than once when moving from one extreme position to the other.

4.5.1 *Coarse change-over selector*

A change-over selector connecting the tapped winding to either the coarse winding or the main winding.

4.5.2 *Reversing change-over selector*

A change-over selector connecting one or other end of the tapped winding to the main winding.

4.6 *Transition impedance*

A resistor or reactor consisting of one or more units bridging the tapping in use and tapping next to be used, for the purpose of transferring load from one tapping to the other without interruption or appreciable change in the load current, at the same time limiting the circulating current for the period that both tappings are used.

4.7 *Driving mechanism*

The means by which the drive to the tap-changer is actuated.

Note.- The mechanism may include an independent means of storing energy to control the operation.

4.8 *Set of contacts*

A pair of individual fixed and moving contacts or a combination of such pairs operating substantially simultaneously.

4.9 *Diverter switch and selector switch contacts*

4.9.1 *Main contacts*

A set of through-current carrying contacts which has no transition impedance between the transformer winding and the contacts and does not switch any current.

4.9.2 *Main switching contacts*

A set of contacts which has no transition impedance between the transformer winding and the contacts and makes and breaks current.

4.9.3 *Transition contacts*

A set of contacts which is connected in series with a transition impedance and makes and breaks current.

Note.- In the case of reactor transition tap-changers, this set of contacts is used, in many instances, to carry the through-current in the full tap position.

4.10 *Circulating current*

That part of the current which flows through the transition impedance at the time when two tappings are bridged during a tap-change operation and which is due to the voltage difference between the tappings.

4.11 *Switched current*

The prospective current to be broken during switching operation by each set of main switching or transition contacts incorporated in the diverter switch or selector switch.

4.12 *Recovery voltage*

The power-frequency voltage which appears across each set of main switching or transition contacts of the diverter switch or selector switch after these contacts have broken the switched current.

4.13 *Tap-change operation*

A complete sequence of events from the initiation to the completion of the transition of the through-current from one tap of the winding to an adjacent one.

4.14 *Cycle of operation*

The movement of the tap-changer from one end of its range to the other and the return to its original position.

4.15 *Insulation level*

The withstand values of the impulse and power-frequency test voltages to earth, and where appropriate between the phases, and between those parts where insulation is required.

4.16 *Rated through-current* (I_u)

The current flowing through the tap-changer towards the external circuit, which the apparatus is capable of transferring from one tapping to the other at the relevant rated step voltage and which can be carried continuously while meeting the requirements of this standard.

Note.- Concerning the relationship between a rated through-current and the relevant step voltage, see Sub-clause 6.2.

4.17 *Maximum rated through-current* (I_{um})

The rated through-current for which both the temperature rise of the contacts (Sub-clause 8.1) and the service duty test (Sub-clause 8.2.1) apply.

4.18 *Rated step voltage* (U_i)

For each value of rated through-current, the highest permissible voltage between terminals which are intended to be connected to successive tappings of a transformer.

Note.- If a rated step voltage is given in connection with a rated through-current, it is called "relevant rated step voltage".

4.19 *Maximum rated step voltage* (U_{im})

The highest value of the rated step voltage for which the tap-changer is designed.

4.20 *Rated frequency*

The frequency of the alternating current for which the tap-changer is designed.

4.21 *Number of tapping positions of the tap-changer*

4.21.1 *Number of inherent tapping positions*

The highest number of tapping positions for half a cycle of operation for which a tap-changer can be used according to its design.

4.21.2 *Number of service tapping positions*

The number of tapping positions for half a cycle of operation for which a tap-changer is used in a transformer.

Note to Sub-clauses 4.21.1 and 4.21.2:

These terms are generally given as the ± values of the relevant numbers; e.g. ±11 positions; they are in principle valid also for the motor-drive mechanism.

When using the term "number of tapping positions" in connection with a transformer, this always refers to the number of service tapping positions of the tap-changer.

4.22 *Type test*

A test made on a tap-changer or the components of a tap-changer, or a range of tap-changers or components all based on the same design, to prove compliance with the standard.

Note.- A range of tap-changers is a number of tap-changers based on the same design and having the same characteristics, with the exception of the insulation levels to earth and possibly between phases, the number of steps and the value of the transition impedance.

4.23 *Routine test*

A test made on each completed tap-changer, the design of which has been verified by type test, to establish that the tap-changer is without manufacturing defects.

5. Definitions relating to motor-drive mechanisms

5.1 *Motor-drive mechanism*

A driving mechanism as in Sub-clause 4.7 which incorporates an electric motor and control circuit.

5.2 *Step-by-step control*

Electrical and mechanical devices stopping the motor-drive mechanism after completion of a tap-change, independently of the operating sequence of the control switch.

5.3 *Tap position indicator*

An electrical and/or mechanical device for indicating the tap position of the tap-changer.

5.4 *Tap-change in progress indication*

A device indicating that the motor-drive mechanism is running.

5.5 *Limiting devices*

5.5.1 *Limit switches*

Electro-mechanical devices preventing operation of the tap-changer beyond either end position, but allowing operation in the opposite direction.

5.5.2 *Mechanical end stop*

A device which physically prevents operation of the tap-changer beyond either end position, but allows operation in the opposite direction.

5.6 *Parallel control devices*

Electrical control devices to move, in the case of parallel operation of several transformers with tappings, all tap-changers to the required position and to avoid divergence of the respective motor-drive mechanisms.

Note.- Such devices would be necessary also in the case of single-phase transformers forming a three-phase bank when each single-phase tap-changer is fitted with its own motor-drive mechanism.

5.7 *Emergency tripping device*

An electrical and/or mechanical device for stopping the motor-drive mechanism at any time in such a way that a special action must be performed before the next tap-change operation can be started.

5.8 *Overcurrent blocking device*

An electrical device preventing or interrupting operation of the motor-drive mechanism for the period in which an overcurrent exceeding a preset value is flowing in the transformer winding.

Note.- Where diverter switches are actuated by spring energy systems, interruption of the operation of the motor-drive mechanism will not prevent operation of the diverter switch if the spring release has been actuated.

5.9 *Restarting device*

A mechanical and/or electrical device restarting the motor-drive mechanism after an interruption of the supply voltage and thus completing a tap-change operation already initiated.

5.10 *Operation counter*

A device indicating the number of tap-changes accomplished.

5.11 *Manual operation of motor-drive mechanism*

Operation of the tap-changer manually by a mechanical device, blocking at the same time operation by the electric motor.

5.12 *Motor-drive cubicle*

A cubicle housing the motor-drive mechanism.

SECTION THREE - REQUIREMENTS FOR ON-LOAD TAP-CHANGERS

(excluding requirements for motor-drive mechanisms)

6. Rating

6.1 *Rated characteristics*

The rated characteristics of a tap-changer are:

- rated through-current;
- maximum rated through-current;
- rated step voltage;
- maximum rated step voltage;
- rated frequency;
- rated insulation level.

6.2 *Interrelation between rated through-current and rated step voltage*

Up to the maximum rated through-current of the tap-changer there may be different assigned combinations of values of rated through-current and corresponding rated step voltage. When a value of rated step voltage is referred to a specific value of rated through-current it is called the "relevant rated step voltage".